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ABSTRACT

Experimental work indicates that students learn more in less time when a computer is properly utilized in the educational process. Surveys of computer use in education and in administration in public secondary schools show that, although the number of schools using computers for instructional purposes is still small, the degree of computer use in these schools is quite high. Problem solving and electronic data processing skills are the principal classroom instructional uses; mathematics is most often the subject area taught with the assistance of a computer. Computers have shown a great ability to motivate students. They are more frequently used as an aid in instruction than as the object of instruction. Most financial support for computer programs in schools comes from the local level and is expected to continue to do so in the future. Schools that use computers for instructional purposes tend to be larger and to send more of their students on to college. Surprisingly, many schools which use computers in instructional settings have not used them previously in administration. (JY)

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COMPUTERS IN THE CLASSROOM

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U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION
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Is the use of a computer a good instructional tool?

How can the computers add strength to classroom instruction?

Do students learn more, or faster when a computer is used?

In what subject areas do computers aid the teacher?

Are schools in any number using computers in the classroom?

How are the computers afforded?

It is to answer these and related questions that this document is prepared for you.

Education has been called upon to meet the demands of our pluralistic society. The diversity of these demands has kept education from establishing specific, defined, and universally accepted goals and only two goals enjoy general acceptance. First, society believes all individuals should have access to education commensurate with their desires and abilities.

Secondly, we are committed to providing instruction which is sensitive to the individual differences of students in ability and interest. The necessity of utilizing different instructional techniques with students who deviate from normal ("the gifted" and "the slow learner") has been recognized for some time. The advent of individualized instruction goes one step further because even "normal" children differ from one another.

Meeting one of these goals without endangering the other presents a formidable challenge to our education system. The problem of accomplishing both goals is compounded by the explosion of population and knowledge. There are more people to whom more must be taught. Educators, striving to meet this demand, have embraced innovational teaching techniques, particularly technology. The last decade has seen the rapid spread of computer use for a great variety of applications in business, industry, the military, and science. The educational system, traditionally conservative, started later in applying computer technology. At first, computer applications were limited to the administrative functions performed in schools. However, computers were soon introduced into the instructional process. It is in this latter area where the greatest growth is taking place.

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Extensive experimental classroom work has been conducted and the results now demonstrate conclusively that the early hopes generated by this new educational tool have indeed been well founded. Students with varying degrees of academic proficiency invariably do better on College Board exams and Scholastic Achievement Tests after being exposed to Computers in the Classroom. For instance, Project LOCAL (Laboratory Program for Computer Assisted Learning) is an activity sponsored and funded jointly by the five Massachusetts communities of Westwood, Lexington, Natick, Needham, and Wellesley and under Title III, *ESEA*, 1965. To quote from their published newsletter:

"The significance of LOCAL's program is perhaps best illustrated by a brief description of some of its concrete results. In the fall of 1967, three groups of average college bound juniors in the Westwood, Massachusetts Senior High School began to take second year algebra, a fact which in itself is not unusual. What was unusual about these groups was that, although all three were taught the same mathematics material by the same teacher, students in two groups received instruction in flowcharting and used this technique of designing and representing problem solutions graphically in doing their homework. Students in one of these two groups also learned computer programming and did homework problems on the computer. The third group, which served as a control group, was taught in the traditional fashion, using lecture, classroom discussion, and ordinary pencil and paper homework assignments.

Over the school year, the group which worked with the computer improved more than either of the other groups in general scholastic and reasoning abilities, as measured by standardized tests. As can be seen in the following figure, *the computer group improved more than twice as much as the control group on a test of general scholastic ability and almost four times as much on a reasoning test.*

Percent Change in Group Mean From Pre-Test to Post-Test

	Abstract Reasoning Test	Scholastic Aptitude Test
Control Group Scores	4.6	2.9
Flowchart Group Scores	9.7	5.1
Computer Plus Flowchart Group Scores	17.2	7.5

From this brief account, it is easy to see why personnel in Project LOCAL schools are enthusiastic about integrating the computer into the mathematics curriculum. Using the computer does seem to enhance learning, primarily by improving the student's problem solving skills and his understanding of the concepts underlying problem solution and it provides its own motivation force."

A widely publicized article appearing in the January 1969 edition of Datamation magazine also points up the spectacular results of this type of instruction. To quote from the text:

"A gratifying result has been the increase in scores made by district students of Scholastic Aptitude Tests, according to Dr. Thomas R. Heslep, Superintendent of the Altoona Area School District. Three years ago, scores of 600 were considered very good, but now scores over 700 are not unusual and several 800 scores have been earned. *Furthermore, comparison of slow learners in mathematics who are using the system with control groups not using it shows a 4 to 1 improvement for those using the system.*"

THE INDICATIONS OF THIS EXPERIMENTAL WORK ARE SIMPLY THAT STUDENTS ARE ABLE TO LEARN MORE IN LESS TIME WHEN THE COMPUTER IS PROPERLY UTILIZED IN THE EDUCATIONAL PROCESS.

This phenomenon is not completely understood even by researchers participating in the study. The most prevalent theory is that the student utilizing the computer is literally taught how to apply his own logic to the solution of various problems. Furthermore, the computer printout provides the instructor with a detailed "blueprint" of the student's thought processes and hence is an invaluable means of determining the strengths and weaknesses of the individual student. Also the emphasis is placed on the *problem solving methods* employed by the student rather than on the actual solutions reached.

As a consequence of this instruction in problem solving methodology, term-end examinations illustrate dramatic improvements in the academic performance of nearly all students.

It can be seen that the computer has a definite role of importance in the process of education. Properly utilized it adds strength to both the administrative and instructional areas. The following are various computer applications which assist in these areas:

(1) **Computer-assisted-instruction**, drill and practice, tutorial and dialogue modes using programmed instructional techniques.

(2) **Computer used as a computational aid** to problem solving in classes and laboratories for science, mathematics, accounting, economics, etc.

(3) **Teaching electronic data processing skills to students.**

(4) **Gaming and simulation of real life situations.**

(5) **Computer-mediated instruction involving TV, film, etc.**

(6) **Any other classroom or laboratory learning applications.**

(7) **Management of instruction**, including individual instructional diagnosis through the analysis of student learning needs and progress and the prescription of individual instruction.

(8) **Guidance and counseling**, including academic guidance, occupational counseling, and personal adjustment counseling.

(9) **Any other application** of a computer for instructional management, guidance and counseling.

(10) **Administrative applications** including:

Student accounting—schedules, attendance records, grades

Resource management

Planning

Research and evaluation

The American Institutes for Research conducted a survey sponsored by the National Science Foundation concerned with the educational and administrative uses of computers in public secondary schools. The principal focus of the study was on instructional, rather than administrative, computer use. The following is a summation of information resulting from this survey:

EXTENT OF ADMINISTRATIVE AND INSTRUCTIONAL APPLICATIONS

(1) Of the schools responding to the survey, 3,776 (30.5%) were using computers for administrative purposes.

(2) There were 1,559 (12.9%) schools surveyed which reported instructional computer use.

Among those schools that are using computers, administrative applications dominate. This domination of administrative over instructional use is of an approximate 2½ to 1 ratio. Comparison of the present survey with earlier studies indicates that instructional use of computers is growing rapidly in the secondary schools in the United States.

DEGREE OF ADMINISTRATIVE AND INSTRUCTIONAL USE AMONG COMPUTER USERS

(1) Of the computers used by instructional users, 41.3% were leased and 28% used on purchased time basis.

(2) Almost 30% of user schools reported using more than one computer for their applications.

(3) Just over half of the computer users reported more than one application and about one-third reported more than two applications in the schools.

(4) In a "typical application," there was a median of 50 students, each of whom participated on the average of about 10 hours per month.

(5) On the average, two teachers each spent about 20 hours per month in a "typical application."

Although the number of schools using computers is still in the minority, *the degree of computer use in these schools is quite high.* There is, of course, wide variation in the degree of use among these schools. However, indicants, such as number of computers used, number of applications, number of students involved, amount of computer time used, and frequency of use show a fairly high degree of computer use.

NATURE AND PURPOSE OF INSTRUCTIONAL USE

(1) The instructional applications listed in order of frequency of mention were: Electronic Data Processing (EDP) skills training, problem solving, guidance/counseling, gaming/simulation, computer assisted instruction, management of instruction, other classroom instructional applications.

(2) A variety of patterns of combinations of applications emerged, clustered around guidance-administrative and problem-solving-EDP skills.

(3) *The most frequently mentioned student activity was writing and running programs with teachers assisting.*

(4) Although the overall purposes of the applications varied widely, there was a *general emphasis on using the computer as a tool to accomplish subject matter goals* rather than on learning about the computer as an end in itself.

(5) Applications of computers to mathematics instruction dominated. Almost three-quarters of all computer applications were involved with mathematics instruction.

(6) There was very little formal integration of computers into the curriculum except in mathematics where there was a little more integration.

(7) The model grade in which instructional computer applications were introduced was grade 10 with some variation across applications within grades 9-11.

(8) Overall the most frequently mentioned programming language used for instructional applications was FORTRAN; second was BASIC.

Problem solving and EDP skills training form the core of classroom instructional uses. Occuring somewhat *less frequently are CAI*—Computer Assisted Instruction--and gaming and simulation applications. *Management of instruction applications occur less frequently.*

The dominance of computer applications by the mathematics curriculum is even more marked than that of problem solving and EDP skills training.

It is known that the computer can be threatening from the standpoint that students frequently learn more about it than teachers do. Therefore, a teacher undertaking a computer application must have sufficient confidence in himself not to be bothered by such an occurrence.

At least one other factor which stands in the way of computers being used more throughout the entire curriculum is concerned with the structure and content of the curriculum. The curricula of most schools, as presently constituted, make it difficult to introduce innovations. A number of computer users have gone to modular scheduling which permits the inclusion into their tight schedules of short so-called mini courses in computer use.

It is safe to conclude that the *computer is more frequently used as a tool in instruction rather than as the object of instruction.* Therefore, the purposes of the computer applications tend to concern themselves with the subject matter such as mathematics, science, and economics. The computer simply aids the student in accomplishing the content goals of the subject area.

A number of interesting controversies surround the instructional use of computers in secondary schools. One of these deals with the mode of use of the computer. At one end of the continuum is the mode in which the computer is used in the classroom on a highly formalized basis. At the other end of the continuum appears the use of the computer in a laboratory setting in a very informal way. In the former mode, the use of the computer is normally planned by teachers and scheduled for use on homework and classroom assignments. When used more informally, the computer is simply made available to students. They are instructed how to use the computer if and when they come to the laboratory to use it. In this way, students may use the computer in a variety of classes as they feel they have a need to use it. In this latter mode of operation, it is the students, rather than the teachers, who spread the use of the computer into various subject areas.

Teachers mentioned that some students get so involved with computers that they neglect their other courses. This causes tensions and jealousies among departments within the schools and frequently has considerable effect on the students' overall academic performance. It must be recognized that the computer is a tool which is designed to aid instruction, not control it. At the same time, computers present a challenge to continue to guide students' learning. If they fail to meet the challenge, students will learn unguided and thus possibly ineffectively.

Many schools have introduced the use of a mini computer, which normally is a small scale inexpensive machine which can be used in the school. It was interesting to note that one cannot judge the sophistication and educational significance of a school's computer use simply on the basis of the sophistication of the computer being used. A more important factor determining the quality of the

instructional application is the expertise and imagination of the teachers involved in the application.

ONE OF THE GREATEST BENEFITS DERIVED FROM THE USE OF COMPUTERS IN INSTRUCTION RESULTS FROM ITS CAPACITY TO MOTIVATE STUDENTS. Why the computer is so effective in motivating students is not easy to answer. Some have suggested that it is the hands-on experience that computers provide. Others suggested that it could be that computers make the subject relevant. This may be particularly true of mathematics. Whatever the reason, it is a significant educational process.

LEVEL AND SOURCE OF SUPPORT OF INSTRUCTIONAL USE

(1) The median cost per school for instructional computing was $14,000. The median percentage of the annual operating budgets of the instructional users as represented by their annual instructional computer budget, was .4%.

(2) More schools (32.3%) indicated that each of their applications cost between $1,000 and $5,000, on the average, than any other range of cost.

(3) Schools reported that 80% of their computer budget comes from local sources and they report the intention of continuing to turn to local sources for the bulk of their support in the future.

(4) Non-local sources mentioned most frequently were: National Science Foundation, Office of Education, state governments and colleges and universities.

(5) A wide variety of different types of cooperative arrangements exist for supporting and developing computer applications between secondary schools and other schools, school systems, colleges and universities, commercial networks and formal networks.

(6) Colleges and universities were mentioned most frequently and computer manufacturers second most frequently as the conductors and sponsors of teacher training for computer use. The National Science Foundation was listed third most frequently as the sponsor of computer training for teachers.

CHARACTERISTICS OF SCHOOLS USING COMPUTERS

Schools which reported instructional applications tended to be larger in enrollment and teaching staff, to send more graduates to college and junior college, and to be more predominately comprehensive senior high schools when compared to those schools not reporting instructional use.

PREVIOUS USE

(1) Instructional computer use frequently developed independently of administrative use.

(2) *Most computer applications which schools reported terminating were administrative (56.8%).*

Possibly the most revealing finding regarding previous use of computers concerns itself with how instructional applications develop. Many have been of the opinion that instructional applications have

developed as a way of getting more use out of a computer which is already being used for administrative purposes. Information from the schools surveyed indicated that this is probably not the case. *Most instructional applications have developed independently of administrative applications within the schools.*

PLANS FOR FUTURE USE

(1) Although funding for computer applications is sometimes a year-to-year proposition, teachers generally appeared confident that the applications will continue indefinitely.

(2) Users indicated a greater intention to initiate new applications than did nonusers. There was a tendency for users to initiate applications similar to those in which they were already involved.

(3) Schools that have computers tend to show preference for expanding present applications with secondary emphasis on initiating new types of applications.

(4) Most frequently mentioned problems dealt with insufficient access to computers thus spurring action toward acquiring computers solely for classroom use.

(5) Needs for future expansion of computer use among instructional users typically involved one or more of the following: funding, training of staff and information.

By reading the foregoing material you will have answered the preliminary questions and can see by actual results why the computer is such a tremendous instructional tool. The computers add strength to the classroom by motivating students and developing within them the skill to apply their own logic to the solution of various problems—thus dramatically helping them to learn more in less time. Although presently computers are utilized more in mathematics, strong indications show that successful applications are spreading rapidly into the other subject areas of the curriculum. Because of the favorable results, personnel currently using computers are confident that funds will be available for continued use.